

Western Electric Co., Incorporated  
Equipment Engineering Branch, Hawthorne

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METHOD OF OPERATION  
Panel System - Testing Circuit - Schematic - For Line Finder Starting Test  
Set

DEVELOPMENT

1. PURPOSE OF CIRCUIT

1.1 This circuit is used for testing the start circuit in panel line finder offices.

2. WORKING LIMITS

2.1 None.

OPERATION

3. PRINCIPAL FUNCTIONS

The principal functions of this circuit are as follows:

- 3.1 To test the (STA) and (GA) relays in the start circuit and indicate by means of the (ST), (X), (K) and (GA) lamps, the satisfactory or unsatisfactory operation of these relays and the continuity of the associated leads.
- 3.2 To test the (STB) and (GB) relays and associated leads and indicate the results by means of the lighting of the (ST), (X), (K) and (GA) lamps.
- 3.3 To test the (CA) and (SA) relays and leads associated with them, indicating the results by means of the (CA) and (SA) lamps.
- 3.4 To test the (CB) and (SB) relays and the associated leads, indicating the results on the (CA) and (SA) lamps.
- 3.5 When two classes of service are provided to test the operation of the (CL1) or the (CL2), (CL3) and (CL4) relays by the operation of key (CL1) or (CL2) respectively.
- 3.6 To test the relative operating speeds of the (STA) and (STB) relays and of the (GA) and (GB) relays by means of the (A) and (B) lamps.
- 3.7 To test the continuity of the "K" lead.
- 3.8 To test the operation of the (KF) relay.

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#### 4. CONNECTING CIRCUITS

##### 4.1 Panel line finder start circuits.

#### DESCRIPTION OF OPERATION

#### 5. PREPARATION

When testing the start circuit of panel line finder equipment, the patching plug which normally patches the trip and line finder circuits to the start circuit, is replaced by the plug of a flexible cord which terminates in a portable box containing the equipment of this circuit. A patching cord is used to furnish battery and ground to the test circuit through the battery jack in the box, from a similar jack located on the line finder frame.

When only sub-group "A" lines and line finders are equipped, connect ground to the 2B contact of the (CB) relay of the start circuit while making the tests.

When only sub-group "B" lines and line finders are equipped, connect ground to the 2B contact of the (CA) relay of the start circuit while making the tests.

If the start circuit is arranged to work with line groups having two classes of service in the same group then one series of tests should be made with the (CL1) key operated and the tests repeated with the (CL2) key operated.

#### 6. (STA) RELAY TEST

The (STP) key is operated until the (A) lamp lights. The (STP) key operated, operates the (STP) magnet. As the (STP) magnet operates its operating circuit is opened at its break contact and the magnet releases, advancing the test selector to position 1. When the test selector is in position 1, the (A) relay operates, lighting the (A) lamp, indicating that the test circuit has moved off normal, and that test is being made on the (STA) and (GA) relays of the start circuit. When the (STP) key is released, the (A) relay locks to ground on the (DISC) key, and the (TR) and (TR-1) relays operate over plug spring 4 to battery on the break contact of the stepper magnet (G) of the start circuit under test. The (TR) relay operated, locks through its 600 ohm winding, operating the (STA) relay in the start circuit over plug spring 15. If key (CL1) or (CL2) is operated, ground for locking relay (TR) comes from the back contact of relay (ST) of the start circuit over plug spring 2 or 3. The function of the (STA) resistance is to reduce the current through the winding of the (STA) relay to a value equal to the operate test requirements of the (STA) relay. The (STA) relay in the start circuit operated,

(a) opens the circuit through the winding of the (TR-1) relay and the 700 ohm winding of the (TR) relay, releasing the (TR-1) relay, (b) operates the (STP) magnet (G) in the start circuit, and (c) connects ground through plug springs 1, 5, 10 and 17. If the (CL1) or (CL2) key is operated, the connection of ground to plug spring 17 will be delayed, as the closing of ground to plug springs 1 and 5 will operate the (ST) relay of the start circuit which will remove the short circuit from the start circuit (CL1) and (CL2) relays, one of which will operate in series with relay (STA) and the 600 ohm winding of (TR) relay and will cause ground to be connected to the spring of relay (STA) which in turn is closed to plug spring 17. Ground on plug spring 10 operates the (X) relay, lighting the (X) lamp. Ground on the plug spring 1, advances the test selector to position 2. When the test selector is in position 2, the (ST) lamp lights. The (X) lamp lighted, indicates the closure of the make contact of the (STA) relay, and the continuity of the lead connected to plug spring 10. The (ST) lamp lighted, indicates the continuity of the leads connected to plug springs 1, 4 and 15, and that the (STA) relay and the stepper magnet (G) have operated satisfactorily. If the lead to plug spring 4 is open, the (TR) and (TR-1) relays do not operate and the (ST) and (X) lamps do not light. If the lead to plug spring 15 is open the (STA) relay does not operate and the (X) lamp does not light.

#### 7. (GA) RELAY TEST

With the test selector in position 2, the (ADV) relay operates and locks to ground on the (DISC) key, operating the (LP) and (LP-1) relays from ground on plug spring 17. The (LP) relay operated, locks through its windings in series to ground on the (DISC) key, and operates the (GA) relay in the start circuit over plug spring 7. The function of the (P), (Q), (R) and (S) resistances is to reduce the current through the winding of the (GA) relay to a value equal to the operate test requirements of that relay. If (CL1) key is operated, the resistances (X) and (Y) are closed in series with the (GA) relay in place of resistances (P), (Q), (R) and (S). This arrangement is provided because the (GA) relay has a different adjustment when the start circuit handles calls from line groups arranged to provide two classes of service in the same group. If key (CL2) is operated, the (Z) relay 19 ohm winding is placed in series with the (GA) relay and in this case the (GA) relay has an additional shunt in the start circuit. When the (GA) relay in the start circuit operates, it locks to ground on the (STA) relay of that circuit, operates the stepper magnet (A) and disconnects ground from plug spring 17, releasing the (LP-1) relay. The (LP-1) relay released, operates the (GLP) relay. If the (CL2) key is operated, the release of the (LP-1) relay will not close a circuit directly to operate relay (GLP) but will await the operation of relay (Z) which will operate and lock and will close a circuit through the back contact of relay (LP-1) to operate relay (GLP). The (GLP) relay operated locks to ground, extinguishes the

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(ST) lamp, lights the (GA) lamp and advances the test selector to position 3. The (GA) lamp lighted, indicates, that the (GA) relay has operated, and the continuity of the leads connected to plug springs 7 and 17. If trouble is encountered during the test of the (GA) relay, the (GA) lamp fails to light and the (ST) lamp remains lighted.

#### 8. TEST OF K LEAD WITH "X" WIRING

With the test selector in position 3, the (STA) relay of the start circuit is held operated over plug spring 6 to ground on arc (ADV). This same ground on plug spring 6 through the break contact of the (SA) relay in the start circuit is connected to plug spring 15, short circuiting the 600 ohm winding of the (TR) relay, which releases. This test is similar in operation to the K commutator of the line finder circuit, which connects ground over plug spring 6 and short circuits the winding of the (TR) relay in the trip circuit in the regular operation of the line finder equipment. The (TR) relay released, advances the test selector to position 4. As the test selector advances from position 3, the (GA) lamp is extinguished, the (GLP) relay releases, also relay (Z), if operated releases, and the holding ground for the (STA) relay in the start circuit is disconnected at arc (ADV), releasing the (STA) relay which in turn releases the (GA) relay, and the (X) relay of this circuit. The (X) relay released, extinguishes the (X) lamp. With the test selector in position 4, and the (GLP) relay released, the (K) lamp lights indicating that the (STA) and (GA) relays have operated, and their associated leads function satisfactorily. If the leads connected to plug springs 6 or 15 are open, the (K) lamp fails to light and the (GA) lamp will remain lighted.

#### 9. TEST OF "K" LEAD WITH "Y" WIRING

With the test selector in position 3, the (STA) relay is held operated over plug spring 15 thru the 600 ohm winding of the (TR) relay. In position 3 the primary winding of the (K) relay is connected to the "K" lead over plug spring 6. The (K) relay will operate indicating that the "K" lead is free from direct ground and is continuous. The (K) relay locks thru the secondary winding and connects direct ground to plug spring 6. The (TR) relay will be short circuited and released. The (TR) relay released and the (K) relay operated closes a path to move the test selector to position 4. The circuit then functions as described in paragraph 8, except that (K) relay releases as the test selector advances from position 4.

#### 10. TEST OF OPERATION OF (KF) RELAY

With the (KF) key operated, the circuit will function as described in paragraph 9 while the test selector is in position 3 except that the ground from the test set for short circuiting the (TR) relay is open at the (KF) key. Under this condition the test set will wait

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until the (KF) relay in the start circuit operates and the interrupter closes and connects a ground on plug spring 15 which will short circuit the (TR) relay. The path to move the test selector out of position 3 will then be closed thru the back contact of the (TR) relay and the front contact of the (K) relay.

11. (STB) AND (GB) RELAYS TEST

The (STP) key is again operated until the (B) lamp lights. As the (STP) is operated the (A), (ADV) and (LP) relays release, and the test selector is advanced to position 5, extinguishing the (K) lamp. When the test selector is in position 5, the (SW), (SW-1), and (SW-2) relays operate. The (SW) relay operated, lights the (B) lamp, indicating that tests are now being made on the (STB) and the (GB) relays of the start circuit. When the (B) lamp lights, the (STP) key is released, causing the (TR) and (TR-1) relays to operate over the same circuit and function in a similar manner to that described in paragraph 6. From this point on the (STB) and (GB) relays are tested in a manner similar to the manner in which the (STA) and (GA) relays were tested. Reference made to the (STA) and (GA) relays and (STP) magnet (A) should be read as the (STB) and (GB) relays and the (STP) magnet (B), and references made to plug springs 1, 6, 7, 10, 15 and 17 should be read as 5, 12, 13, 14, 16 and 18 respectively. The circuits for this test are through the make contacts of the (SW), (SW-1), (SW-2) relays, instead of the break contacts. The test selector positions 1, 2, 3 and 4 of the previous test, correspond to positions 5, 6, 7 and 8 respectively of this test. With the test selector in position 8, the (K) lamp lights, providing tests of the (STB) and (GB) relays prove satisfactory as described in paragraphs 8, 9 and 10. If (CL1) or (CL2) key is operated, relay (GK) will operate and lock in position 8 of the test selector. (GK) relay operated provides an operating circuit for the start circuit (CL1) relay.

12. (CA) AND (SA) RELAYS TEST

The (STP) key is again operated until the (A-BB) lamp lights, disconnecting the locking ground from the (SW), (SW-1), (SW-2), (LP) and (ADV) relays, which release, advancing the test selector to position 9. When the test selector is in position 9, the (SW-2) and (SW-3) relays operate. The (SW-3) relay operated, lights the (A-BB) lamp and connects ground to plug spring 15, operating the (STA) relay in the start circuit. The (STA) relay operated, operates the (C) relay of the test circuit over plug spring 10 and short circuits the 500 ohm winding of the (CA) relay in the start circuit. If the start circuit is arranged for two classes of service, the operation of the (STA) relay in the start circuit will operate relay (ST) which removes the short from relay (CL1) which operates from battery through resistance (Z) and a contact of relay (GK) of the test circuit. If the short

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around the winding of the (CA) relay is ineffective, the (CA) relay will operate causing (CA) lamp to light as hereinafter described. If the (CA) lamp does not light it indicates that the short around the winding of the (CA) relay in the start circuit is effective. (REL) key should be operated disconnecting ground from plug spring 15, releasing the (STA) relay in the start circuit. When the (STA) relay releases, the short around the winding of the (CA) relay is opened, allowing the (CA) relay to operate to ground on the contact of the (C) relay, and ground is disconnected from plug spring 10, but the (C) relay is held operated from ground on the contacts of the (REL) key. The (C) relay will not release during the operation of the key, due to its slow release characteristics preventing the (CA) relay in the start circuit from releasing, by the disconnection of ground from plug spring 11. The (REL) key operated, also operates the (RG) relay. The function of the (H) and (I) resistances is to reduce the current through the inner winding of the (CA) relay to a value equal to the operate test requirements of that relay. When the (CA) relay of the start circuit operates, it locks through its 1000 ohm winding, in series with the (CL) relay, which operates. The (CL) relay operated, in turn operates the (CL-1) relay, lighting the (CA) lamp, and advancing the test selector to position 10. If the lead associated with plug spring 11 is open the (CL) relay would not operate, and the (CA) lamp would not light. When the (REL) key is released ground is again connected to plug spring 15, operating the (SA) relay. The function of the (T) or (T) AND (U) resistances is to reduce the current through the winding of the (SA) relay to a value equal to the operate test requirements of that relay. The (SA) relay operated, in turn operates the (STB) relay. The (STB) relay operated, connects ground to plug springs 14 and 18, releasing the (CL) relay and holding the (CA) relay of the start circuit operated. The (CL) relay released, releases the (CL-1) relay, extinguishing the (CA) lamp and advancing the test selector to position 11. When the test selector advances from position 10, the (SW-2) and (SW-3) relays release, extinguishing the (A-BB) lamp and when the test selector is in position 11, the (SA) lamp lights. In order to prevent the time alarm being brought in by the start circuit, (REL) key should be operated within 2 seconds of the time that (STA) relay operates. When testing start circuits arranged for 2 classes of service in the same group, (CL) relay may operate and cause (CA) lamp to light if (REL) key is not operated within this time, even if (CA) relay has not operated. In start circuits not arranged for two classes of service, the operation of (STB) relay operates the test circuit (X) relay over plug spring 14, this will cause (X) lamp to light in case the shunt around the (CA) relay was not effective. In start circuits arranged for two classes of service, the circuit for operating (CL) relay is over plug spring 14 and front contacts of (GK) relay. In start circuits not arranged for 2 classes of service, the circuit for operating (CL) relay is over plug spring 17. Should the shunt around (CA) relay be open when (C) relay first operates, (CA) relay would operate and lock as above, in series with (CL) relay, operating it, (CL-1) and (CL-2) relays

would operate, (CA) lamp would light, the switch would step to position 10, (SA) and (STB) relays would operate and (CL) relay would be shunted down as above, but provided (REL) key is not operated, (RG) relay will not be operated and (CL-1) relay will lock, preventing the switch from stepping out of position 10, and keeping (CA) lamp lighted.

13. (CB) AND (SB) RELAYS TEST

When the (SA) lamp lights, indicating that the (CA) and (SA) relays have functioned, or that the test selector has been advanced, the (STP) key is again operated, until the (B-AB) lamp lights, indicating that the test of the (CB) and (SB) relays of the start circuit is now being made. The (STP) key operated, opens the locking circuit of the (RG) relay which releases, and advances the test selector to position 12, operating the (SW-3), (SW-4) and (SW-5) relays. The (SW-4) relay operated, lights the (B-AB) lamp. When the lamp lights the (STP) key is released, closing locking ground through the windings of the (SW-4) and (SW-5) relays. From this point the circuit functions in a similar manner to the test of the (CA) and (SA) relays, with the following exceptions. Reference made to the (CA) and (SA) relays, should be read as the (CB) and (SB) relays respectively, and reference to plug springs 10, 11, 14, 15 and 18 should be read as 14, 8, 10, 16 and 17, respectively. The circuits for this test are traced through the make contacts of the (SW-4) and (SW-5) relays, instead of the break contacts, and through the break contacts of the (SW-2) relay instead of the make contacts as in the test of the (CA) and (SA) relays. The test selector positions 9, 10 and 11 of the previous test correspond to the positions 12, 13 and 14 of this test.

14. RELATIVE SPEED TESTS OF (STA) AND (STB) RELAYS

When the (SA) lamp lights, indicating that the (CB) and (SB) relays have functioned or that the test circuit has been advanced, the (STP) key is again operated, advancing the test selector to position 15 and releasing the (SW-4) and (SW-5) relays. When the test selector is in position 15, the (T) relay operates, operating the (STA) and (STB) relays simultaneously. The (STA) and (STB) relays operated, connect ground to the plug springs 17 and 18, under the control of the (GA) and (GB) relays respectively. Ground on plug spring 17 lights the (A) lamp, and ground on plug spring 18 lights the (B) lamp. When testing start circuits, not arranged for two classes of service, the operation of (STA) relay operates (X) relay over plug spring 10, lighting (X) lamp. The relative operating speed of the (STA) and the (STB) relays is determined by the difference in time of the lighting of the (A) and (B) lamps. When the starting circuit is arranged for two classes of service ground is not connected to the spring of relays (STA) and (STB) until relay (ST) operates removing the short circuit on relay (CL1) which operates to supply this ground. In this case the lighting of lamps (A) and

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(B) does not indicate relative speed of operation of relays (STA) and (STB) but merely that they operate and bring about the subsequent operation of relay (CL1).

#### 15. RELATIVE SPEED TESTS OF (GA) AND (GB) RELAYS

The relative operating speed of the (GA) to the (GB) relay, is determined by operating the (REL) key, which extinguishes the (A) and (B) lamps at the speed the (GA) and (GB) relays operate. When the (REL) key is operated, the (T-1) and (RG) relays operate. The (RG) relay operated extinguishes (X) lamp, if lighted. The (T-1) relay operated connects ground to plug springs 7 and 13, operating the (GA) and (GB) relays respectively. The operation of the (GA) and (GB) relays disconnects the ground from plug springs 17 and 18, extinguishing the (A) and (B) lamps at the speed that the (GA) and (GB) relays operate. The (GA) and (GB) relays operated, lock to ground on the (STA) and (STB) relays. When the (REL) key is released, the (T-1) relay releases.

#### 16. REPEAT SPEED TEST

To repeat the speed test of the (STA), (STB), (GA) and (GB) relays, the (T) key is operated, releasing the (T) relay. The (T) relay released, disconnects ground from plug springs 15 and 16, releasing the (STA) and (STB) relays, which in turn release the (GA) and (GB) relays. When the (T) key is released, the (T) relay is again operated, and the speed test is repeated as described in paragraphs 14 and 15. In order to prevent the time alarm being brought in by the start circuit, (REL) key should be operated and released and (T) or (DISC) key should be operated within 2 seconds of the lighting of the (A) and (B) lamps.

#### 17. DISCONNECTION

The test circuit is restored to normal, by operating the (DISC) key. The (DISC) key operated, opens the locking ground, releasing any relays that are locked to that ground, and operates the (DISC) relay. The (DISC) relay operated, locks to ground, lights the (DISC) lamp and advances the test selector to its normal position. When the test selector is in its normal position the locking circuit of the (DISC) relay is opened at arc (RN) and the relay releases when the (DISC) key is released. With the (DISC) relay normal, the (DISC) lamp is extinguished, and the circuit is normal.

ENG.  
E.L.F.  
4-22-35  
B.A.S.

CHK'D. E.L.F.

APP'D. A. PENROD  
S.C.E.